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(54) Abstract Title
Cooling panels for blast furnaces

(57) A cooling panel 300 for a blast furnace includes at least one internal passageway 312 for conducting a coolant media and is formed by a casting process including the provision of at least one internal core forming a passageway 312, the material of the core being removed after casting. This allows the internal passageways 312 to be non-linear. The cored cooling channels 312 can also be non-circular in cross-section, a particularly preferred cross-section being trapezoidal as this presents a larger cooling surface than one with a circular cross-section. A trapezoidal cross-section also allows the cooling channel depth to be reduced, in turn reducing the stave body thickness and giving scope for further increases in furnace volume. The staves can be retro-fitted into existing furnaces which have previously employed iron staves. It is preferred that the stave is cast of copper or a copper alloy, but the invention can be applied to the use of other materials.

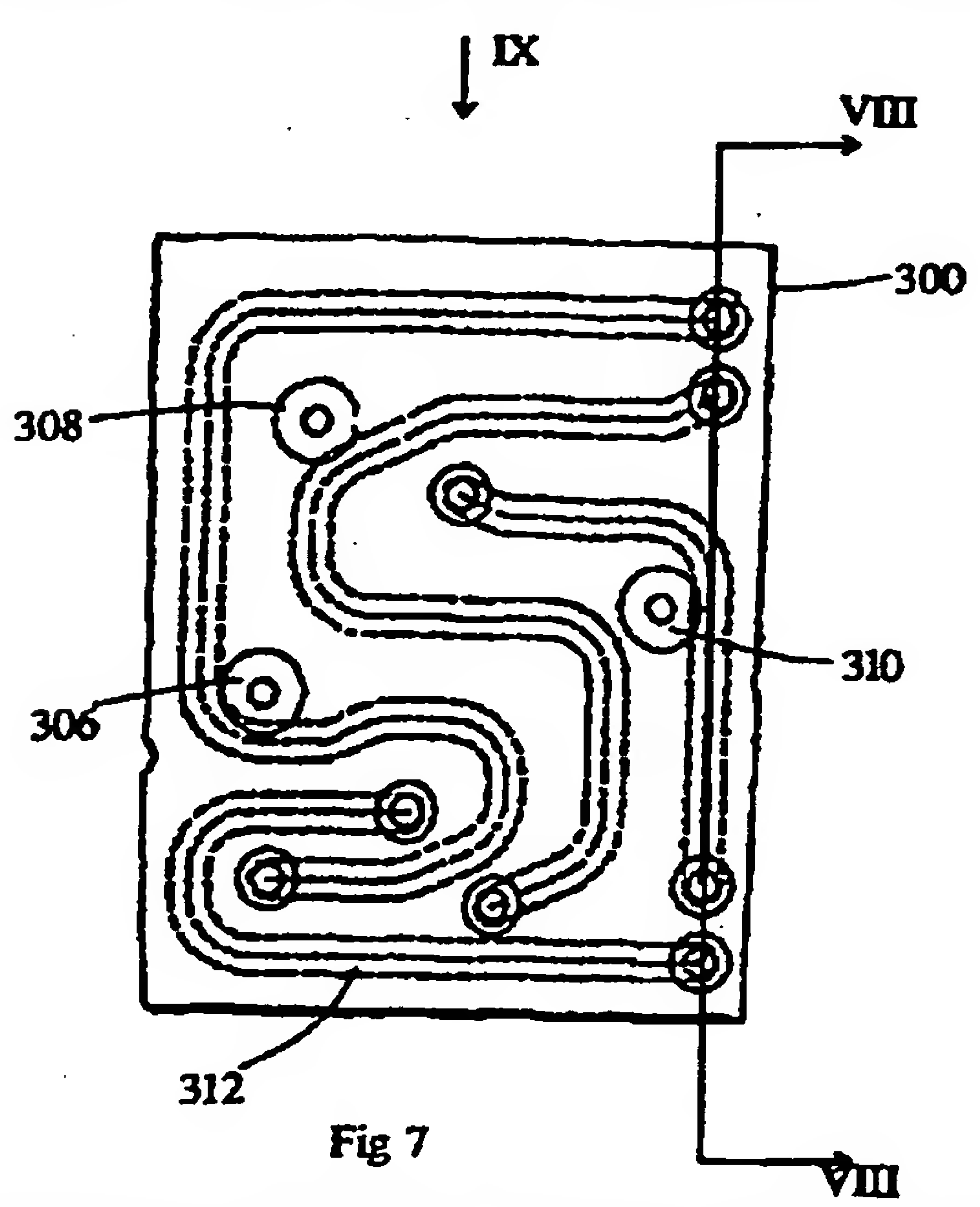

Fig 7

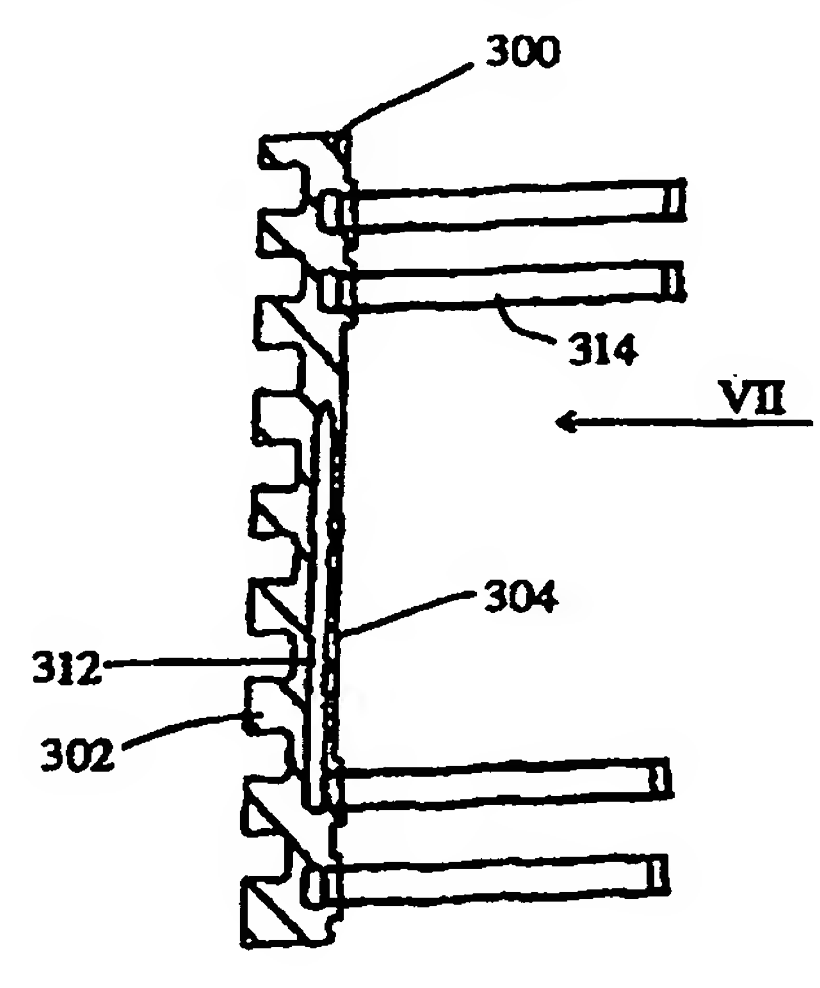

Fig 8

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

The claims were filed later than the filing date but within the period prescribed by Rule 25(1) of the Patents Rules 1995.

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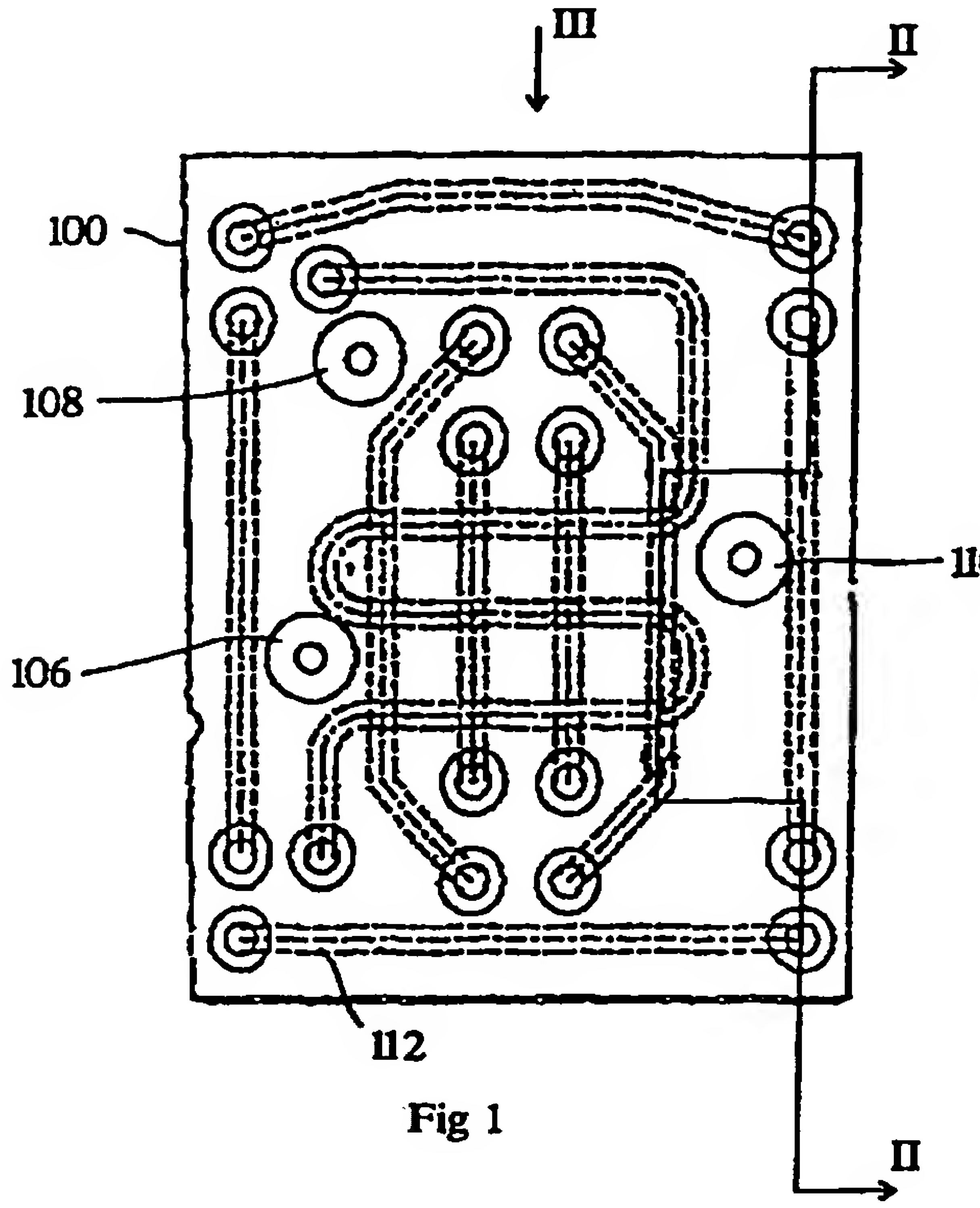

Fig 1

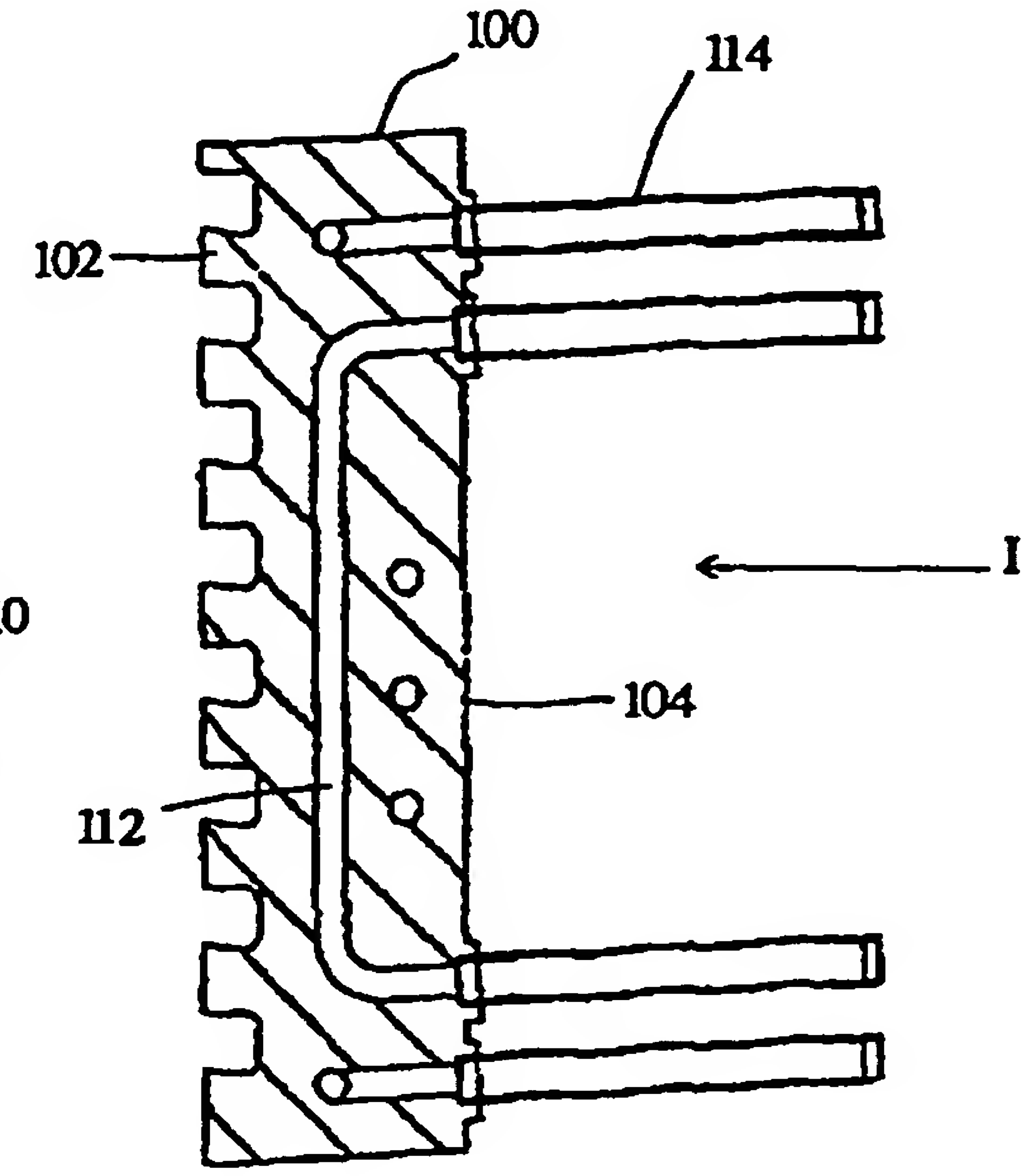

Fig 2

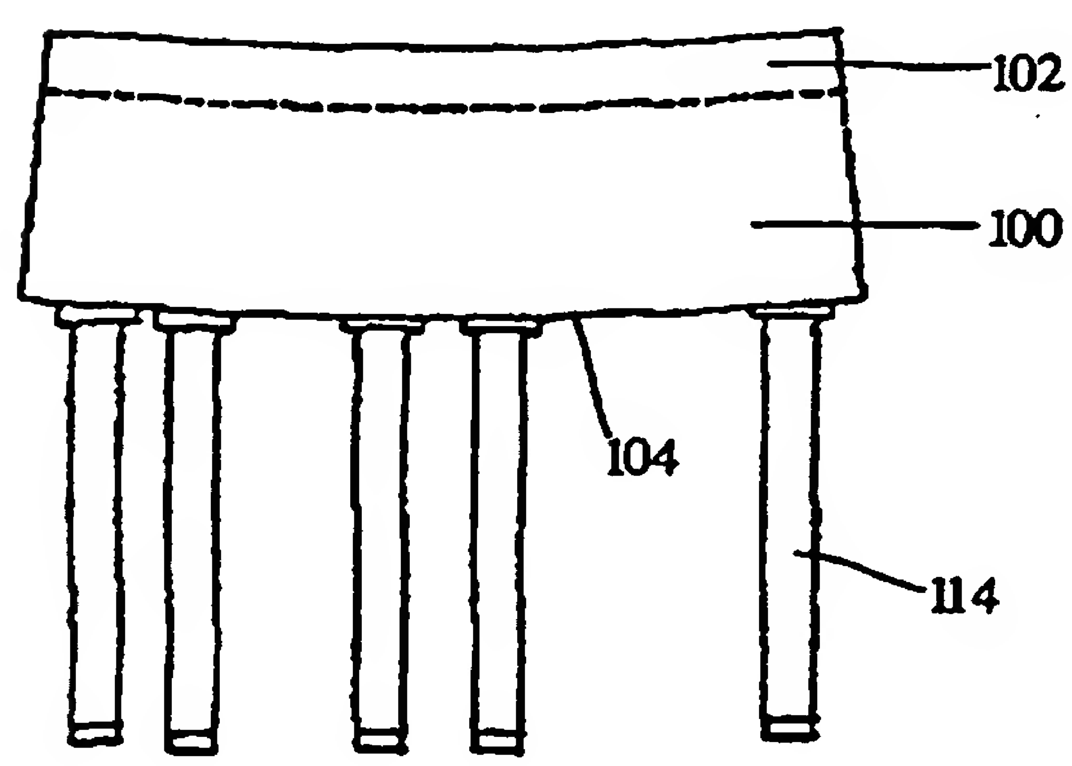

Fig 3

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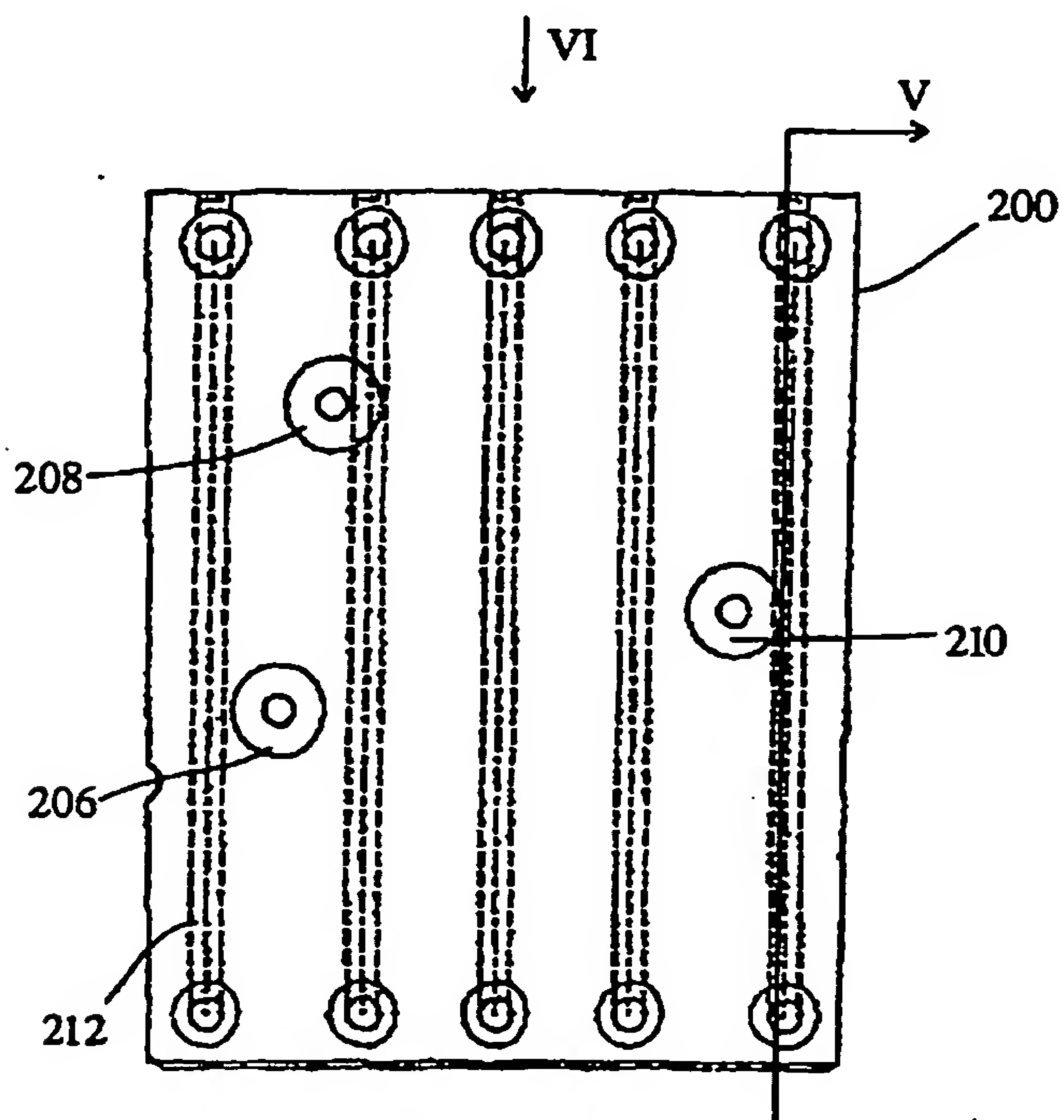

Fig 4

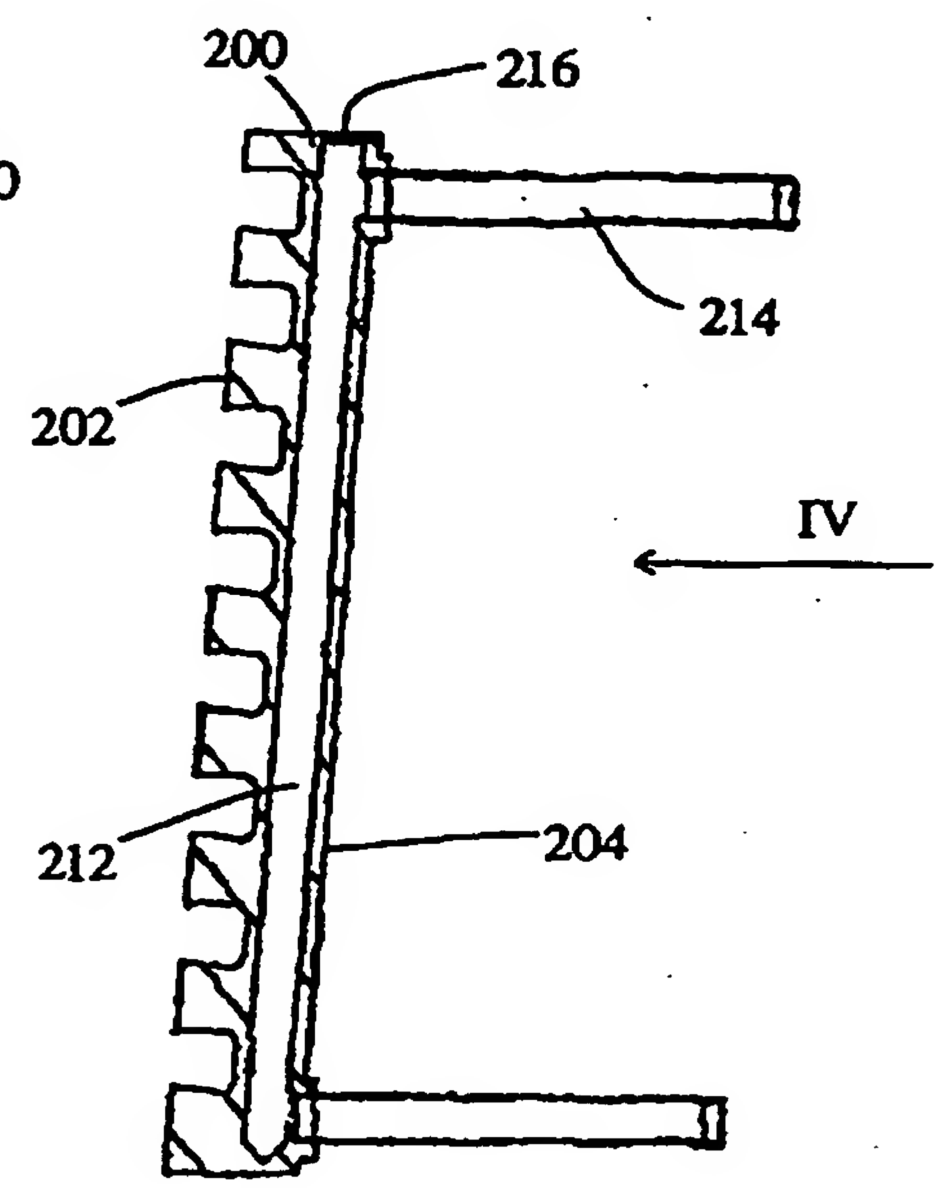

Fig 5

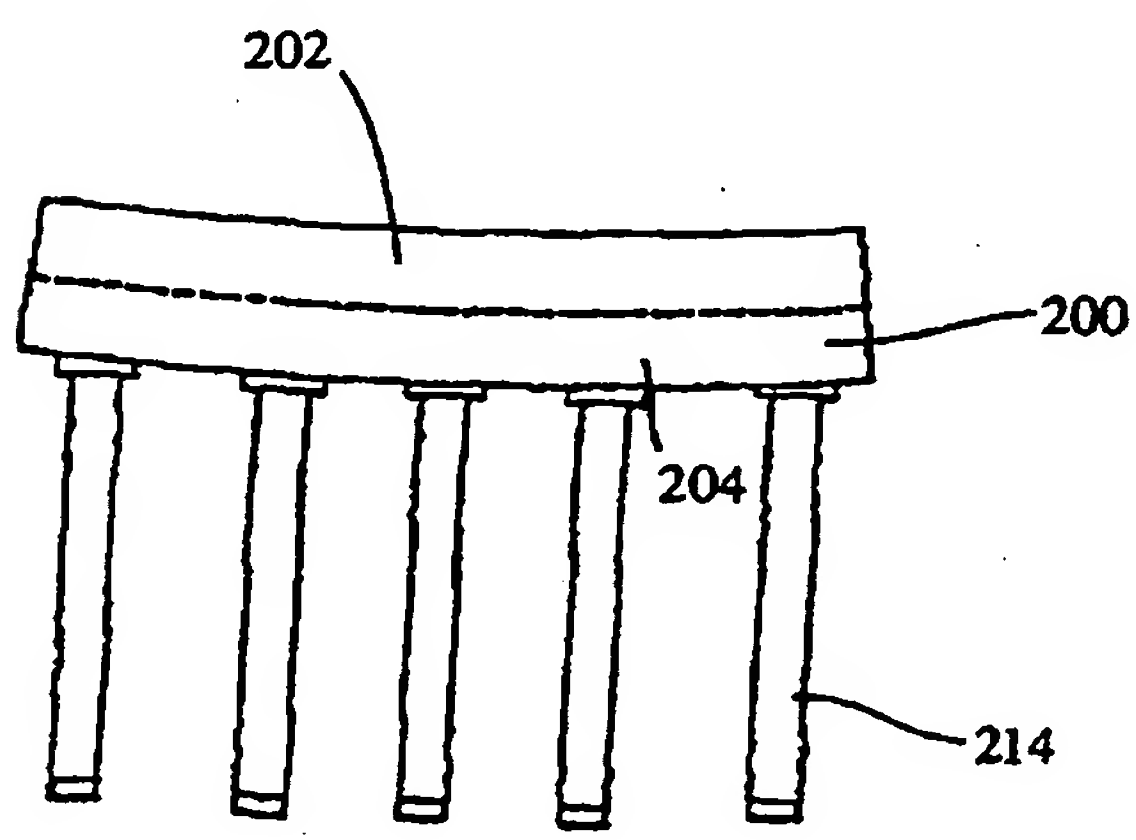

Fig 6

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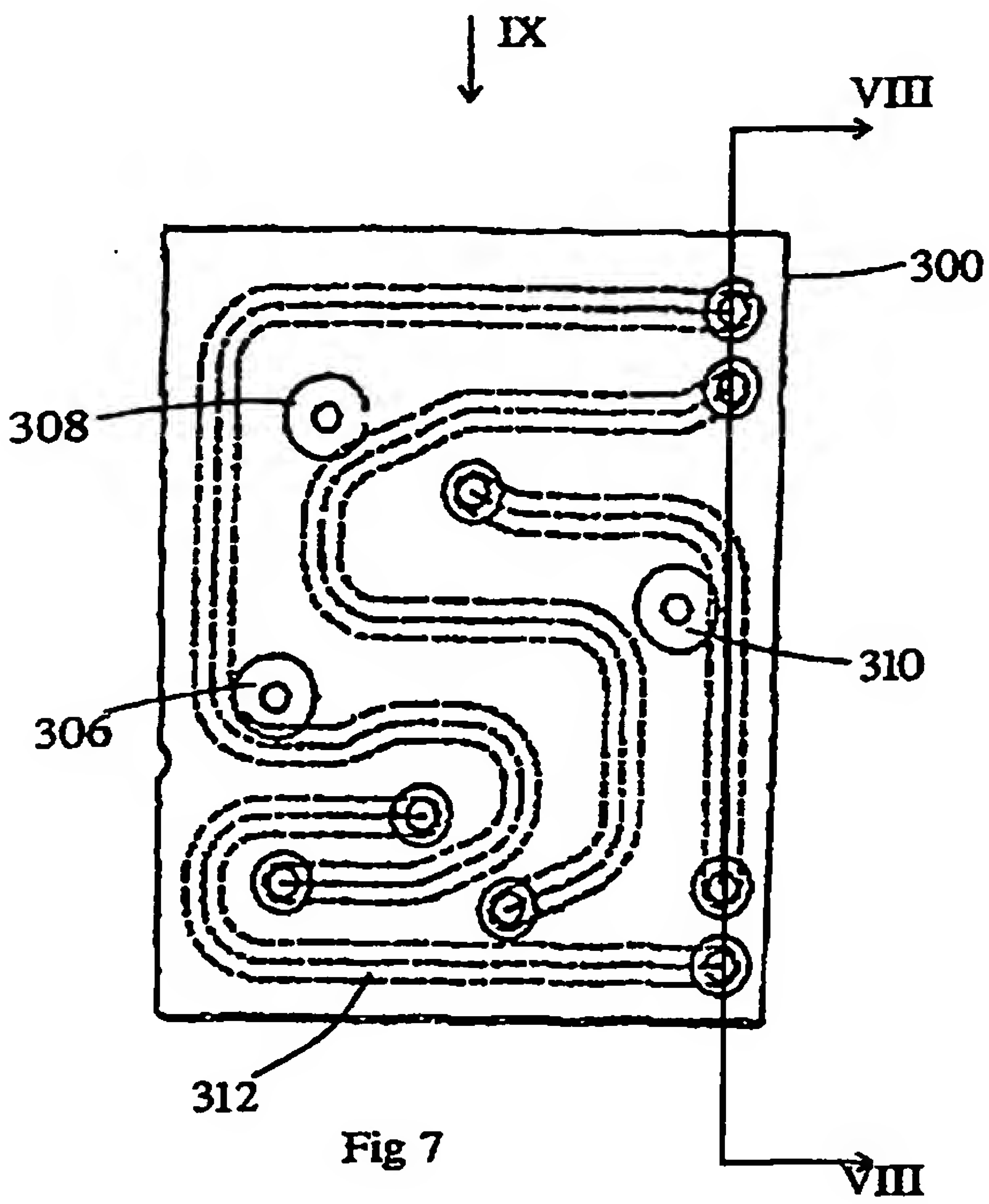

Fig 7

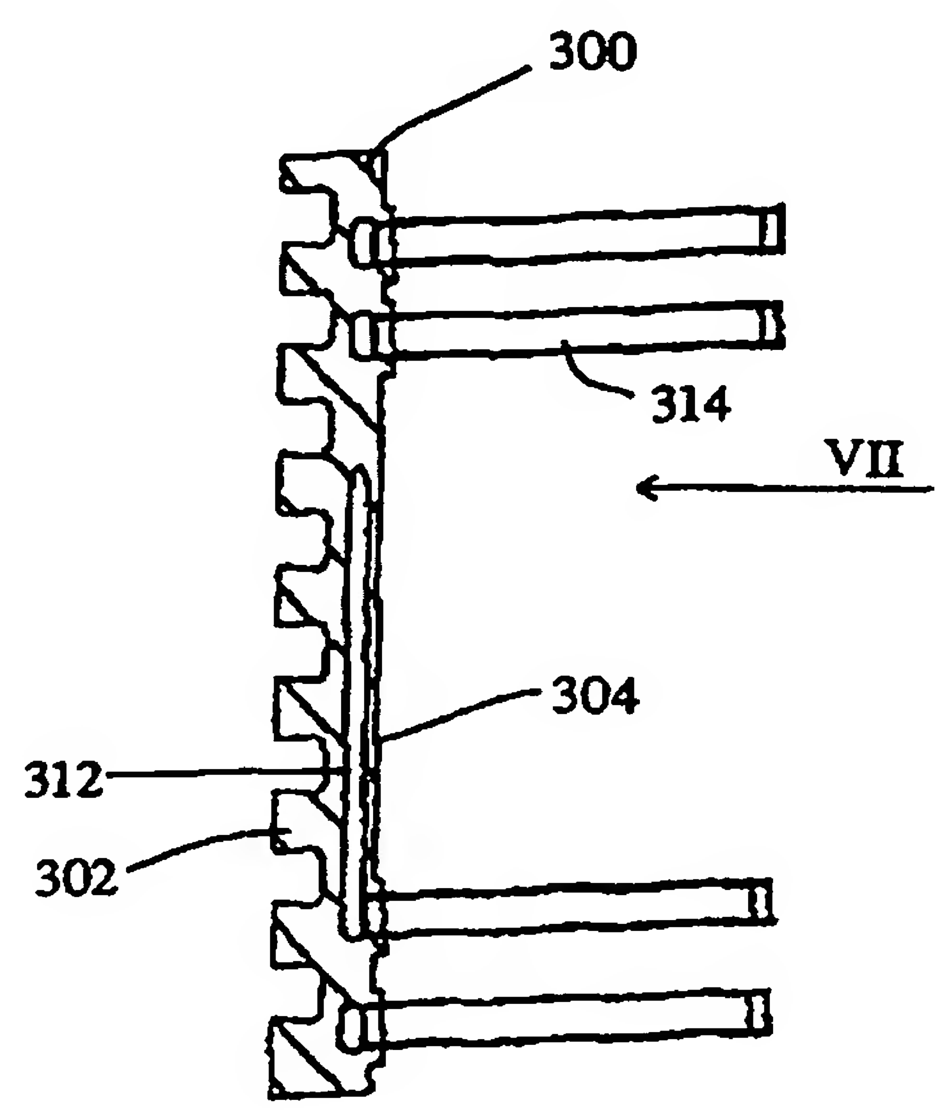

Fig 8

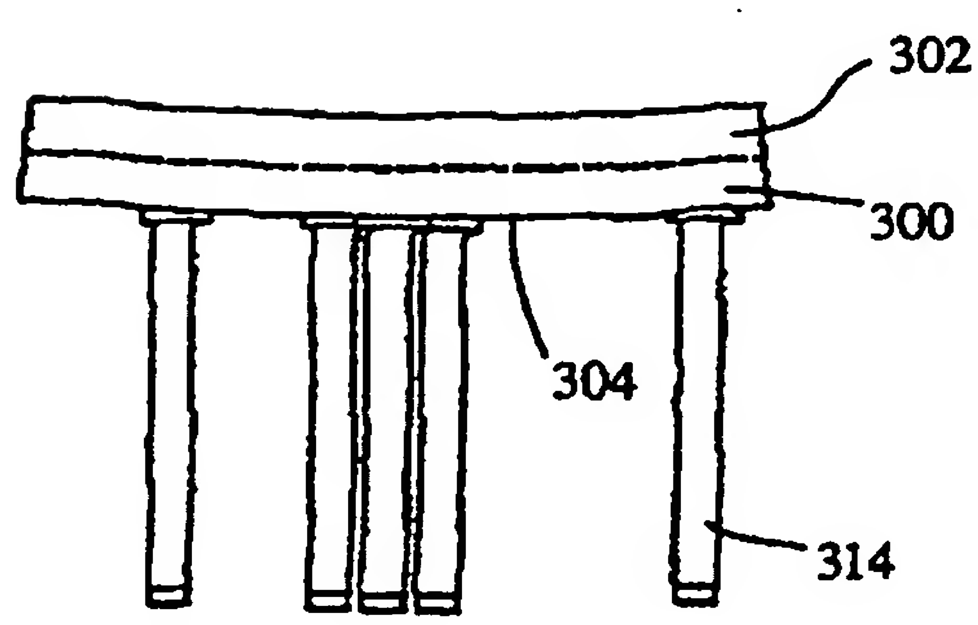

Fig 9

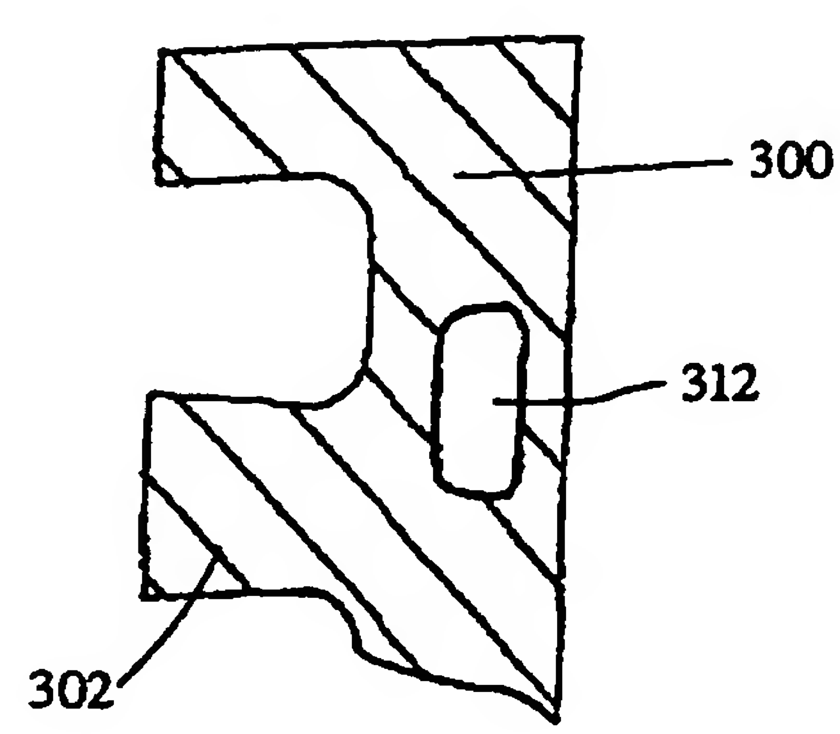

Fig 10

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COOLING PANELS FOR BLAST FURNACES

The present invention relates to cooling panels for blast furnaces.

Blast furnaces incorporate cooling elements within the walls thereof so as to withdraw heat and protect the furnace shell. One form of shell cooling involves cooling panels which have historically been manufactured from cast iron, using pipes inserted prior to casting to create an internal cooling network. An example is illustrated in Figures 1 to 3 described more fully later. The panels are positioned inside the furnace shell wall and are protected from direct contact with the furnace environment by a layer of refractory bricks. The hot face of the panel is usually formed with castellations to allow the refractory bricks to be keyed into the panel, normally referred to as a stave. Water or other cooling media are then pumped through the internal pipe network of the stave, cooling the stave body and in turn cooling the furnace wall. It is normal to employ several pipes so as to ensure effective cooling of the panel even in the event of a coolant supply problem due to pipe blockage or possibly rupture. The pipes are also formed in an elaborate network to maximise their cooling efficiency.

A difficulty with this type of cooling -panel is the low thermal conductivity of cast iron. This means that the relative durability of cast iron cooling panels under conditions of high heat loading is somewhat poor. In general, refractory lining wear during a blast furnace campaign will increasingly expose the staves to the furnace environment. In the later stages of a campaign, this can cause rapid degradation of the panels. In many instances, staves have been exposed to the furnace environment for significant periods of time and have been eroded back sufficiently to reveal the internal pipe networks. In extreme cases this has led to failure of

cooling elements.

Alternative materials have therefore been considered for the stave panel. Copper has been used since at least the 1970s, and since then copper staves have been used increasingly in place of cast iron in the constructions of new furnaces. At present, stave cooling panels are manufactured from pure copper and low alloyed copper in both cast and wrought form. In the future, the usage of copper staves is expected to grow despite the relatively high material costs, as these are offset by a substantially improved campaign life resulting from the superior heat transfer properties.

Unlike staves manufactured in cast iron, copper stave panels cannot include an internal pipe network. There is clearly no opportunity to introduce such a network if the copper panel is wrought, and foundry processes prevent the successful introduction of pipes into a cast copper panel. The copper staves produced to date have therefore been manufactured by drilling water channels within the cast or wrought block. An example is illustrated in Figures 4 to 6, described more fully later. The internal channel is drilled as a blind hole, and the open end is then sealed with a suitable plug which can be welded in place. Perpendicular channels can then be drilled to make communication with the internal bore thus forming an internal cooling passageway.

The present invention provides a cooling panel for a blast furnace including at least one internal passageway for conducting a coolant media, the panel being formed by a casting process including the provision of at least one internal core thereby to form a passageway, the material of the core being removed after casting.

This allows the internal passageways to be non-linear. Drilled internal bores that are formed in existing copper stave panels must of course be

straight and this prevents use of the elaborate internal passageway designs typically employed in cast iron staves in order to optimise heat flow.

The cored cooling channels can also be non-circular in cross-section. A particularly preferred cross-section is trapezoidal, as this presents a larger cooling surface than one with a circular cross-section. Thus, for the same cross-sectional area, the effective cooling surface area supplied by a stave according to the present invention can be greater than that for known copper staves. A trapezoidal cross-section also allows the cooling channel depth to be reduced, in turn reducing the stave body thickness and giving scope for further increases in furnace volume.

The cores can be supported within the mould by supports, if necessary, and the holes formed by the core supports later sealed.

The use of the present invention further allows the placement of the coolant supply and drain pipes to match the positions of the pipework for conventional cast iron panels. Where the internal passageways are drilled, the pipework positions are of course dictated by the drilling process. Thus, copper staves according to the present invention can be retro-fitted into existing furnaces which have previously employed iron staves, allowing restoration work to be undertaken mid-campaign without the need for furnace shell alterations or external pipework modification.

It is of course preferred that the stave is cast of copper or a copper alloy, but the invention can be applied to the use of other materials.

An embodiment of the present invention will now be described by way of example, together with illustrative examples of known stave panels, with reference to the accompanying Figures, in which;

Figure 1 shows a rear view of a known cast iron stave panel;

Figure 2 shows a vertical cross-section along II-II of Figure 1;

Figure 3 shows a view on III of Figure 1;

Figure 4 shows a rear view of a known copper stave panel;

Figure 5 shows a vertical cross section on IV-IV of Figure 4;

Figure 6 shows a view on VI of Figure 4;

Figure 7 shows a rear view of a cast copper stave panel according to the present invention;

Figure 8 shows a vertical section on VIII-VIII of Figure 7;

Figure 9 shows a view on IX of Figure 7; and

Figure 10 shows an enlarged cross-section of Figure 7 illustrating a cooling channel in more detail.

Figure 1 shows a cast iron stave panel 100. Its front face is formed with castellations 102, whilst the rear face 104 is substantially smooth. Bolt holes 106, 108 and 110 are formed at distinctive positions within the stave panel to allow it to be fixed in place.

A circuitous pattern of internal passageways 112 are formed within the body of the stave panel 100. Prior to casting, pipes of an appropriate bore are placed within the mould in the desired pattern, following which the molten cast iron is introduced. As a result of pipe preparation and foundry process control the pipe network survives casting and provides internal passageways. The particular pattern illustrated in Figures 1-3 is chosen so as to optimise the heat transfer properties of the panel. It leads to a

distinctive positioning pattern for the outlet pipes 114, which is catered for in the pattern of supply pipes (not shown).

In use, the stave panel is fitted within the wall structure of a blast furnace between the external shell and the internal refractory bricks. A suitable coolant such as water is passed through the internal pipe network and this withdraws heat from the stave panel. This cools both the refractory lining and the furnace shell, thereby affording some protection to both.

Figures 4, 5 and 6 illustrate a known form of stave panel made from cast or wrought copper. The panel 200 is again formed with castellations 202, but obviously cannot contain copper pipework. Instead, after formation of the panel 200, internal passageways 212 are formed by drilling in the plane of the panel 200. The bores thus formed are blind as is apparent from Figure 5, and the open end is sealed with a plug 216. Perpendicular bores are then made at the top and bottom of panel 200 so that the supply pipework 214 can communicate with the internal passageway 212 thus formed. This does of course mean that the passageways must be straight and cannot adopt the convoluted pattern shown in Figure 1. Thus, the optimal heat transfer properties may not be obtained and retrofit applications would necessitate significant structural alteration to the furnace steel. However, the copper substrate of the panel 200 offers greater resilience and heat transfer properties and this is sufficient to overlook this shortcoming.

The internal bores 212 must also be positioned so as to avoid bolt holes 206, 208 and 210.

Figures 7-9 illustrate an embodiment of the present invention. The panel 300 is formed of cast copper, in which suitable cores have been provided in the original mould. These cores allow internal voids to be formed within the cast item. The cores need to communicate with the

exterior of the item so that the sand or glassy material forming the cores can be removed. However, they permit a convoluted internal structure of passageways 312 that both avoids the bolt holes 306, 308 and 310 whilst providing a network which is optimal for heat removal. They can also employ supply pipe positions which correspond to positions in a cast iron stave panel. This means that cast copper stave panels of this type can be used as a one for one replacement with cast iron panels, for example in the renovation of an existing blast furnace. This greatly widens their applicability, since it will be unnecessary to completely renew the coolant supply network.

Figure 10 also shows the internal passageway 312 in more detail. It can be seen that the external profile of the passageway is one of a smoothed trapezium. This allows particularly effective heat removal per unit cross-sectional area of the passageway. It is also somewhat narrower than the bores of Figures 4-6, allowing the panel to be made still more narrowly than any of the previously described examples.

It may be necessary to provide supports for the internal cores at points within the mould. These will provide leakage paths which can be sealed with plugs such as employed in Figures 4-6.

It will of course be appreciated that the above described example is purely illustrative of the present invention, and that many variations may be made thereto without departing from the scope of the present invention.

CLAIMS

1. A cooling panel for a blast furnace including at least one internal passageway for conducting a coolant media, the panel being formed by a casting process including the provision of at least one internal core thereby to form a passageway, the material of the core being removed after casting.

2. A cooling panel according to claim 1 in which the internal passageways are non-linear.

3. A cooling panel according to claim 1 or claim 2 in which the cooling channels are non-circular in cross-section.

4. A cooling panel according to claim 3 in which the cross-section of the cooling channels is trapezoidal.

5. A cooling panel according to any preceding claim in which the cores are supported within the mould by supports and the holes formed by the core supports later sealed.

6. A cooling panel according to any preceding claim in which the stave is cast of copper or a copper alloy.

7. A cooling panel substantially as described herein with reference to and/or as illustrated in the accompanying figures 7 to 10.

The Patent Office

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INVESTOR IN PEOPLE

Application No: GB 9826850.1
Claims searched: 1-7

Examiner: Kalim Yasseen
Date of search: 8 November 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): F4B (BFB, BNB)

Int Cl (Ed.6): F27D (1/00, 1/12)

Other: Online: EPODOC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	WO 98/30345 A1	(WURTH) a furnace cooling panel, see whole document especially the abstract and figures	at least 1, 2, 4
A	FR1432629 A	(HUET) see whole document especially the figures	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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